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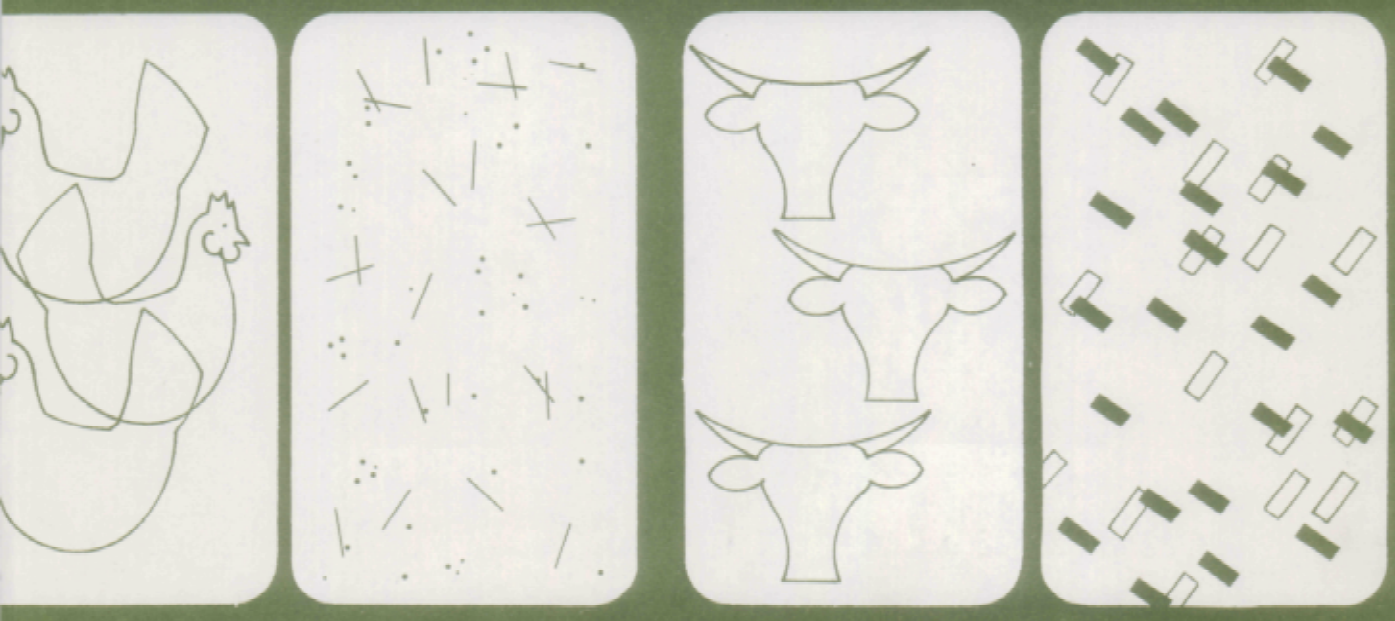
AIR SEPARATION OF ALFALFA INTO HIGH AND LOW PROTEIN FRACTIONS – AN ECONOMIC EVALUATION



ABSTRACT

Five separated dehydrated alfalfa products of different protein levels were evaluated using prices of feed ingredients from four different markets and three different time periods in both poultry and cattle rations. This evaluation shows that in some market situations the economic value of dehydrated alfalfa (dehy) can be increased by separation. The study also describes how the value of separation can be estimated.

The method for air separating the light leafy fraction, which is high in protein and low in fiber, from the denser stem fraction, which contains most of the fiber, was developed by the Western Regional Research Center, Agricultural Research Service, USDA. This technique provides the potential for producing dehydrated alfalfa products that can be more efficiently utilized by different livestock classes.

Keywords: Alfalfa, dehydrated alfalfa, livestock feeds, feed prices, marketing, linear programming, feed ingredients.

PREFACE

The National Economic Analysis Division, Economic Research Service, in cooperation with the Western Regional Research Center has attempted to provide more economic knowledge for expanding market outlets and increasing the efficiency of marketing farm products. This study is one of a series in the cooperative research program between the two agencies of the U. S. Department of Agriculture. Two of these reports are: Alfalfa Meal in Poultry Feeds--An Economic Evaluation Using Parametric Linear Programming, Agr. Econ. Rpt. No. 130, January 1968, and Wheat Millfeeds in Livestock Rations--An Economic Analysis, Agr. Econ. Rpt. No. 219, January 1972.

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SUMMARY AND CONCLUSIONS

In some market situations the value of dehydrated alfalfa (dehy) can be increased by separating it into products with different levels of protein by an air separation method developed by the U. S. Department of Agriculture. Air separation is not always profitable but it can be if alfalfa products are tailored to fit the requirements of specific livestock rations. This tailoring could result in higher profits to the alfalfa dehydrator, greater returns to the alfalfa producer or livestock feeder, or lower meat prices to the consumer.

Dehy is used in many types of poultry and ruminant rations. Its value in a specific ration depends on its quality, the levels of nutrients required in the particular ration, and the prices of other ingredients. In all livestock and poultry rations, energy and protein are major factors determining the price or value of an ingredient. However, the ingredients selected for use in the ration are often determined by other nutrient components. For example, dehydrated alfalfa usually enters a least cost poultry ration because of its xanthophyll content (pigmenting factor). Unidentified growth and reproductive factors in dehy also are important in both poultry and cattle rations.

Separation of dehy provides two or more products, each with specific advantages for feeding different classes of livestock and poultry. The lighter (leafy) material is high in protein, vitamins, and xanthophyll and low in fiber which makes it most suitable for poultry and swine. The heavier (stem) material is somewhat lower in protein and higher in fiber and is more suitable for feeding cattle. With the development of improved separation techniques, the dehydrator has the potential of producing various dehydrated alfalfa products to meet the needs of specific rations.

Layer and broiler finisher rations were used to evaluate the high protein products and a beef finisher ration with roughage was used to evaluate the lower protein products. Dehy products of 13, 15, 17, 20, and 22 percent protein were evaluated.

Values estimated by parametric linear programming and market prices were used to determine the economic benefits of separation. In a series of hypothetical model systems, high and low protein alfalfa products were evaluated to determine the differences in total value from separation. Ingredient prices in four market areas--Los Angeles, Tri-Cities (Rock Island-Davenport-Moline), Boston, and Atlanta--over three time periods were used to provide a wide range of market conditions.

Gross differences in the value, exclusive of separation costs, between separated and unseparated dehydrated alfalfa of 15, 17, and 20 percent protein level were computed. Net differences would have to allow for separation costs which range from $0.30 to $3.24 per ton depending on the method of separation and the size of operation.

For the 15 percent material, separation proved better in all markets for the three time periods. Gross differences between separated and unseparated products ranged from $0.42 to $15.30 a ton. The average unweighted increase in value was $6.36 a ton. Separation of 15 percent starting material into 13 and 17 percent products returned the highest average difference--$7.59 a ton.

For the 20 percent separation alternatives, there was a positive but smaller difference than for the 15 percent ones. The gross difference averaged $2.97 in favor of separation. The most profitable alternative appears to be separation of the 20 percent starting material into 17 and 22 percent products. The value from these products was about $4.04 a ton greater than the market price of the 20 percent starting material.

Even without deducting separation costs, the separation of 17 percent starting material appears to be unprofitable for all of the four alternatives. On the average, a dehydrator would have lost $5.02 a ton through separation. The alternative with the smallest loss was the separation into 13 and 22 percent products. An average loss of $2.49 a ton would have resulted with this separation as compared with selling the unseparated product.

Thus, even though separation does not result in an increase in value of dehy in all situations, there are opportunities for a dehydrator to increase the value of dehy in different livestock feeds by producing separated products for specific market situations.

Each dehydrator must consider many factors in determining the feasibility of separation. Costs would vary widely depending on the system of separation and the capacity of the operation. The more markets available to the dehydrator, the greater is his potential for separation. He should consider the worldwide demand for feed ingredients as well as the total domestic demand for his products in each of his markets and the distribution of this demand between livestock and poultry rations. Availability of ingredients that compete with dehy also would have a definite effect on his decision. Certain commodities may compete strongly with some dehydrated alfalfa products but may be available in only limited quantities during certain times of the year. The dehydrator should consider his capability to provide any desired quality of dehy product the year round. Separation, in addition to the present practice of blending, would add considerably to his ability to do this regardless of the quality of his raw material supply.

High protein alfalfa products processed by air separation have potential use in poultry and swine rations. For this potential to be realized, however, the alfalfa dehydrator must develop and promote the use of these products in these rations.

AIR SEPARATION OF ALFALFA INTO HIGH AND LOW PROTEIN FRACTIONS

-AN ECONOMIC EVALUATION

by

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INTRODUCTION

Dehydrated alfalfa (dehy) is an important ingredient in many kinds of livestock feeds. In poultry feeds, xanthophyll and protein are generally considered to be the most important nutrients in dehy but the indigestible fiber of the product limits usage to low levels. For ruminant feeding, the fiber portion of the plant is largely utilized and dehy helps to increase urea utilization, improve palatability, and add natural protein to mixed feeds.

Other benefits to both ruminant and nonruminant animals from alfalfa and certain other feed ingredients that are generally referred to as unidentified growth and reproductive factors (UGF) have not been quantified. These benefits, which seem to be reflected in market prices for alfalfa, have been described by a number of researchers (11, 12, 22, 26, 27).[2/]

Most dehydrated alfalfa is sold at 17 percent protein grade. However, some is also sold at grades of 15, 18, 20, 22, and 25 percent protein. These products are obtained by segregating lots with different natural protein levels and by blending. Typically, alfalfa produced in the early spring and late fall is high in protein and vitamins, while July and August production is of much lower quality. Large storage facilities are necessary for the high and low grades if the dehydrator is to meet feeders' demands for both grades of products throughout the year. Further, adverse weather conditions in some years result in overall low quality so that blending to produce the higher grades is impossible.

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2/ Underscored numbers in parentheses refer to items in Literature Cited, p. 17.

During the late 1960's, personnel at the Western Regional Research Center developed a technique for separating whole dehy (2). This method uses controlled velocity air currents in a specially designed closed system to separate the light from the heavy particles. The lighter or leafy fraction of dehy contains most of the xanthophyll and is high in protein. The heavier or stem fraction contains less of the protein and more of the fiber. This technique of "air separation" enables the alfalfa dehydrator to produce and market alfalfa products designed for specific types of rations insofar as they are economically feasible.

Economic values are established for separated dehydrated alfalfa products. These can be compared with prices of unseparated dehy and thus provide alfalfa dehydrators and livestock feeders with information on the feasibility of air separating dehy.

PROCEDURE

Feed formulators and livestock feeders typically use linear programming to formulate least cost rations which meet specific nutritional requirements. Linear programming requires the specifying of nutrient levels in the ration for the livestock class being studied (that is, the nutritional requirements plus a margin of safety), the nutritional coefficients of the available feed ingredients that can be used in the ration, and the prices of these ingredients. This information is then used to derive the particular combination of feed ingredients which meets the ration specifications at least cost.

By use of parametric linear programming, the values or maximum prices at which an ingredient will be accepted at different levels in a least cost ration can be determined. This will show the effect of a change in the price of an ingredient on the quantity of its use in the ration. This is accomplished by assigning a high arbitrary value to the ingredient under study so that it is not initially accepted in the ration. The computer is programmed to incrementally reduce the price of that ingredient. At each price level the quantity of the ingredient which will be accepted in a least cost ration is recomputed (5, 25). This results in a series of prices at given levels of use. In this study, only one of these prices was used to arrive at an estimated price for the dehydrated alfalfa products for which there were no quoted market prices. We have called this price the imputed value. Market prices were always available from one or more sources for 17 and 20 percent dehy. Since there were no quoted prices for 13, 15, and 22 percent protein products, imputed values were used for these products.

In all cases, imputed values were calculated with the market price of the closest competing alfalfa product priced into the parametric linear programming model. Thus, when a value was estimated for 13 percent protein dehy in the beef finisher ration, the price of 15 percent sun-cured alfalfa hay was programmed into the matrix. When estimates were made for the value of 15 percent dehy, the market price for 17 percent was used in the matrix; and when imputed values were calculated for 22 percent protein dehy, the market price of 20 percent was used in the estimation.

The imputed value selected for products containing 13 and 15 percent protein was at a point when a minimum of 2.5 percent of the ration was made up of this product. For 22 percent protein product, a minimum of 0.5 percent had to be accepted in the ration before the imputed value for this ration was selected. These decisions were somewhat arbitrary, but for the vast majority of the parametric runs the first point of entry exceeded these minimums and in the remaining runs the first point of entry resulted in prices that were unrealistically high.

In deciding whether to air separate dehy into high and low protein fractions, a dehydrator must know the costs of separation as well as the market value of the end products. Both aspects are covered in this study.

Two geographic areas were developed as models to determine profitability of air separation--California and Kansas-Nebraska. These areas are large producers of dehydrated alfalfa. Their production and marketing activities are quite varied, primarily because of geographical location and weather.

Alfalfa dehydrators have essentially two markets--domestic and export. Since export sales and prices are difficult to obtain, only domestic markets were considered in this study. The major markets were used to represent the demand area for the midwestern dehydrators--Tri-Cities (Rock Island-Davenport-Moline), Boston, and Atlanta. Los Angeles represents the demand center for dehy produced in California.

Analyses of both areas include ruminant and poultry rations as a basis for establishing the values of the dehydrated alfalfa products. The use of these rations and a number of assumptions made for this analysis will be discussed later in the report.

Nutritional Coefficients of Feed Ingredients

Feed ingredients used in formulating mixed feeds contain varying quantities of nutrients that are essential for satisfying the nutritional requirements of livestock and poultry rations. In formulating least cost rations through linear programming, feed manufacturers assign values for each of the nutrients in each feed ingredient. The actual values of different lots of a given ingredient would have to be based on the analytical values and the biological availabilities of nutrients in that lot. These may vary widely depending on location of production, the length of time the ingredient has been stored, its moisture content, and cultural practices. Under actual operating conditions, however, there is no practical way to analyze each lot of ingredient. Therefore, nutrient values used by feed manufacturers are based on averages which are considered to be realistic for the feed ingredients (6).

The values assigned to the different nutrients in each feed ingredient used in this analysis were developed at USDA's Western Regional Research Center. They are a blend of data derived from many sources (3, 4, 8, 10, 13, 14, 15, 19, 21). The nutritional values for each ingredient used in the poultry and beef cattle matrices in this analysis are shown in tables A-1 and A-2. Some of these values may have to be adjusted to represent a particular region at any given time.

Nutritional Value of Dehydrated Alfalfa in Different Rations

The nutritional value of dehydrated alfalfa depends greatly on the ration being formulated and, in the case of ruminant rations, whether it is competing as a roughage or nonroughage. Tables 1 and 2 provide the nutritional coefficients for each of the dehydrated alfalfa products analyzed in both poultry and ruminant rations. These coefficients were developed through feeding trials and chemical analyses of these products. Analytical values of air-separated products of the same grade do not differ significantly from these values.

Imputed values were developed for dehydrated alfalfa products in one cattle ration and two poultry rations. The cattle ration is beef finisher with roughage and the poultry rations are layer light breed and broiler finisher. Dehydrated alfalfa products of 13, 15, and 17 percent protein were considered as a roughage in the beef finisher ration. In the poultry rations, 17, 20, and 22 percent protein dehy were evaluated as nonroughage ingredients. In ruminant rations of the same protein level, animal performance is about the same when 13 to 17 percent protein dehy products are fed (1, 9, 24).

Table 1--Nutritional values of dehydrated alfalfa products in poultry and swine feeds

Nutrient name	Unit	Dehy with protein contents of:		
		17%	20%	22%
Metabolizable energy	Kcal/lb.	750.00	780.00	800.00
Protein	Percent	17.00	20.00	22.00
Arginine	do.	.75	.98	1.01
Glycine	do.	.88	1.01	1.21
Isoleucine	do.	.84	.98	1.16
Lysine	do.	.73	.87	1.03
Methionine	do.	.28	.33	.38
Methionine + cystine	do.	.46	.56	.62
Threonine	do.	.75	.88	1.05
Trytophan	do.	.45	.46	.55
Phosphorus	do.	.23	.27	.28
Calcium	do.	1.30	1.47	1.47
Fiber	do.	24.30	20.20	18.50
Xanthophyll	Milligrams/lb.	117.00	149.00	182.00

Source: Dehydrated Alfalfa Assay Report, Third Edition, American Dehydrators Association, 5800 Foxridge Drive, Mission, Kans. 66202.

Table 2--Nutritional values of dehydrated alfalfa products in ruminant feeds

Nutrient name	Dehy with protein contents of:		
	13%	15%	17%
	Percent		
Total digestible nutrients	51.0	54.0	56.0
Total protein	13.0	15.0	17.0
Digestible protein	9.7	11.2	12.7
Fat	1.5	1.90	2.3
Calcium	1.22	1.31	1.39
Phosphorus	.24	.25	.26
Roughage (dry weight)	100.00	100.00	100.00

Source: Unpublished data, Feedstuffs Unit, Western Regional Research Center, Agricultural Research Service, USDA.

The value of unidentified growth and reproduction factors in alfalfa was not included in the imputed values of the separation products determined by computer analysis. More information is needed before a rigorous interpretation of the value of UGF in poultry and ruminant rations can be made.

Nutritional Requirements

Each class of livestock and poultry has different nutritional requirements for optimum health, growth, and rate of productivity. Nutritionists and livestock feeders do not always agree on what these requirements should be. Therefore, published information frequently shows discrepancies. The ration specifications used for this analysis were developed at USDA's Western Regional Research Center. These specifications are a blend of information from a variety of sources (3, 4, 7, 8, 13, 16, 17, 18, 19, 20, 23, 29). Values used for each class of livestock and poultry included in this analysis are presented in tables A-3 and A-4.

Trace Minerals and Vitamins

To assure that requirements for trace minerals and vitamins are being satisfied, many feed manufacturers routinely add fixed quantities of the appropriate trace mineral-vitamin premix to each mixed feed. These manufacturers consider that the amounts of these nutrients naturally found in the ingredients provide a margin of safety in meeting the nutritional requirements. Other feed manufacturers make allowances for the trace minerals and vitamins that are natural to the feed ingredients and thereby are able to produce somewhat lower cost feeds. In this analysis, no allowance was made

for the value of the vitamins and trace minerals naturally occurring in the feed ingredients. Furthermore, requirements for individual trace minerals and vitamins were not included in the nutritional specifications for each diet.

Markets, Time Periods, and Ingredient Prices

The value of dehy depends on supply and demand conditions and prices of competing ingredients, as well as the ration requirements. Since prices of competing ingredients vary over time and in different markets, computations were made for four market locations and for three different time periods representing a wide range of market conditions. Rations selected for the estimates were the most important for the locations that were chosen. The market locations, time periods, and rations used in this study are given in table 3.

Table 3--Markets, rations, and time periods used in analyses of dehydrated alfalfa products

Time period and market	Beef finisher with roughage	Layer light breed	Broiler finisher
11/66-1/67			
Atlanta	--	--	X
Boston	--	X	--
Tri-Cities	X	X	--
Los Angeles	X	X	--
8/68-10/68			
Atlanta	--	--	X
Boston	--	X	--
Tri-Cities	X	X	--
Los Angeles	X	X	--
11/71-1/72			
Atlanta	--	--	X
Boston	--	X	--
Tri-Cities	X	X	--
Los Angeles	X	X	--

The three time periods correspond to quarter years and include the periods November 1966-January 1967, August 1968-October 1968, and November 1971-January 1972. The quarterly price of each ingredient used in the analysis is a simple average of 13 weekly prices (see tables A-5 through A-8). These

prices are based largely on weekly quotations by the Federal-State Market News Service. Prices not available from market news were obtained directly from mixed feed manufacturers and livestock and poultry feeders in each of the locations. In the Tri-Cities area of Rock Island-Davenport-Moline, most prices are based on quotations obtained directly from feed manufacturers and livestock feeders.

Average prices used in this study generally represent the bulk delivered price paid by the feed manufacturer or feedlot operator. Prices do not include the cost of processing grains such as grinding or cooking or the cost of formulating and mixing the ingredients.

Products from Air Separation

Many alternative separation products can be obtained from the dehy starting material. Commercial dehydrators will have different needs for particular end products. Some will want a small quantity of high protein leaf fraction permitting the coarse fraction, in most cases, to retain either 15 percent or 17 percent protein. Others will want to obtain a large quantity of a somewhat lower protein content, leaving a coarse fraction at a high protein level. At times, dehydrators may wish to obtain as much as possible of a 17 percent protein product from starting material which runs well below this level.

Air separation is easily adjusted to the density and quality of the starting material. When a plant operator becomes familiar with the process, he can adjust the flow as the starting dehy material changes in density and quality. An experienced operator realizes that he must adjust his operation to accommodate the variations in the starting material and the market demand. Table 4 gives some of the combinations of products possible from specific starting materials.

VALUE ANALYSIS OF SEPARATED ALFALFA PRODUCTS

Imputed values of the separated fractions for the different rations, markets, and time periods were compared with the market price or imputed value of the starting material to determine the feasibility of separation. In tables B-1 through B-10, the market prices and imputed values were weighted by the separation percentages as shown in table 4. In some comparisons, the weighting of the two imputed values provided the weighted average value of the separated products. With other comparisons, an imputed value and a market price were weighted to develop the weighted average value.

In the Los Angeles market analysis, all material was consumed in that market. However, other comparisons involved two markets. In the Boston-Tri-Cities and Atlanta-Tri-Cities analyses, the Tri-Cities imputed value of market price was used for the lower protein products (13, 15, and, in some cases, 17 percent). For the higher protein products in these comparisons either the Boston or Atlanta imputed values or market prices were used. This blended value was then compared with the imputed value of 15 percent protein dehy or the market price of 17 or 20 percent dehy to estimate the increase or decrease in value due to separation.

Table 4--Percent of starting alfalfa material obtained by selected separation alternatives[1/]

Starting alfalfa material and separation alternatives	Separated dehydrated alfalfa products				
	13%	15%	17%	20%	22%
	Percent				
15% protein					
I	50.0	--	50.0	--	--
II	71.0	--	--	29.0	--
III	77.5	--	--	--	22.5
17% protein					
I	42.5	--	--	57.5	--
II	--	60.0	--	40.0	--
III	--	71.5	--	--	28.5
IV	55.0	--	--	--	45.0
20% protein					
I	--	29.0	--	--	71.0
II	--	--	40.0	--	60.0
III	22.0	--	--	--	78.0

1/ Additional alternatives for separation are shown in (2), tables 17, 18, and 19.

Imputed values and market prices for the five alfalfa products are summarized in table 5 for the different markets and time periods. These data provide the basis for the analyses in this study, since they were used to arrive at differences between the value of separated and unseparated products in each market. Table 6 summarizes these differences.

The differences shown in table 6 represent the total price spread between the separated and unseparated products. The additional expense of separation must be deducted from the differences shown to arrive at comparable values. Separation costs for various sized operations are presented later in this report. Detailed comparisons of differences in value between separated and unseparated products may be found in the tables in appendix B. In these tables, it is possible to relate the values and market prices of the various products in each evaluation. However, for ease of comparison and evaluation, the summary data in table 6 are used in this discussion.

The separation of both 15 percent and 20 percent starting materials increased the value in most cases. Separation of 17 percent material, however, increased the value in only 9 of the 48 assumed cases.

Table 5--Imputed values and market prices for selected dehydrated alfalfa products, by markets and time periods

Time periods and products	Atlanta		Boston		Los Angeles		Tri-Cities	
	Imputed value	Market price	Imputed value	Market price	Imputed value	Market price	Imputed value	Market price
	Dollars per ton							
11/66-1/67								
13%	--	--	--	--	40.80	--	34.80	--
15%	--	--	--	--	45.40	--	37.60	--
17%	--	69.80	--	71.00	--	53.40	--	68.20
20%	--	75.80	--	79.40	--	58.00	--	74.80
22%	96.40	--	91.60	--	71.40	--	78.40	--
8/68-10/68								
13%	--	--	--	--	35.40	--	33.40	--
15%	--	--	--	--	37.80	--	35.40	--
17%	--	45.20	--	49.20	--	55.20	--	41.60
20%	--	51.20	--	54.20	--	57.00	--	49.20
22%	64.20	--	62.20	--	67.60	--	63.40	--
11/71-1/72								
13%	--	--	--	--	42.60	--	35.20	--
15%	--	--	--	--	45.00	--	38.00	--
17%	--	61.80	--	61.60	--	56.00	--	52.40
20%	--	67.80	--	66.60	--	58.60	--	59.40
22%	88.20	--	75.20	--	68.80	--	64.20	--

Table 6--Gross differences in value of separated alfalfa products over starting alfalfa products[1/]

Market location and time period	15% Alfalfa			17% Alfalfa				20% Alfalfa		
	13% & 17%	13% & 20%	13% & 22%	13% & 20%	15% & 20%	13% & 22%	15% & 22%	13% & 22%	15% & 22%	17% & 22%
	Dollars per ton									
11/66-1/67										
Los Angeles	+ 1.70	+ 0.42	+ 2.30	- 2.70	- 2.90	+ 1.20	- 0.60	+ 6.67	+ 5.86	+ 6.20
Tri-Cities	+13.90	+ 8.80	+ 7.00	-10.40	-15.70	-13.80	-19.00	- 5.99	- 8.25	- .45
Atlanta-Tri-Cities	+ 9.80	+ 9.10	+11.10	-15.80	-11.30	- 6.30	-14.20	+ 7.40	+ 3.94	+ 7.50
Boston-Tri-Cities	+15.30	+10.10	+ 6.60	- 9.36	-15.00	- 9.10	-16.00	+ .60	- 2.06	+ 6.75
8/68-10/68										
Los Angeles	+ 7.50	+ 3.90	+ 4.90	- 7.30	- 9.70	- 5.30	- 8.90	+ 3.52	+ 1.96	+ 5.64
Tri-Cities	+ 2.10	+ 2.60	+ 8.80	+ .90	- .60	+ 5.30	+ 1.80	+ 7.60	+ 6.10	+ 5.50
Atlanta-Tri-Cities	+ 3.90	+ 3.15	+ 5.00	+ .05	0.00	+ 3.90	+ .80	+ 6.60	+ 5.25	+ 2.95
Boston-Tri-Cities	+ 5.90	+ 4.00	+ 4.50	- .63	- 1.70	+ 1.40	- .90	+ 3.00	+ 1.83	+ 3.55
11/71-1/72										
Los Angeles	+ 4.30	+ 2.25	+ 3.50	- 4.20	- 5.50	- 1.60	- 4.22	+ 4.43	+ 3.30	+ 5.08
Tri-Cities	+ 5.80	+ 4.25	+ 3.75	- 3.25	- 5.80	- 4.20	- 6.90	- 1.58	- 2.80	+ .15
Atlanta-Tri-Cities	+10.50	+ 6.70	+ 9.15	- 3.80	- 2.06	+ 2.40	- 2.60	+10.00	+ 7.24	+ 8.75
Boston-Tri-Cities	+10.40	+ 6.30	+ 6.20	- 4.40	- 6.60	- 3.40	- 2.60	+ 1.40	- .99	+ .30

1/ Gross differences taken from tables in appendix B. These differences do not include an allowance for separation costs which range from $0.30 to $3.24 per ton depending on method and size of operation (table 7).

Separation of 15 percent material resulted in an increase in value in all markets and all time periods. Increases ranged from $0.42 to $15.30 a ton. The average unweighted increase in value for all separations was about $6.36 a ton. Separation of 15 percent starting material into 13 and 17 percent products returned the highest average difference in value--$7.59 a ton.

For the 20 percent separation alternatives, there was less difference between the value of separated products and that of the starting material than for the 15 percent separation. Overall, an average difference in value of $2.97 existed in favor of separation. The most profitable alternative was separation of the 20 percent starting material into 17 and 22 percent products. The additional value from this separation was about $4.04 a ton greater than the market price of the 20 percent material.

Separation of 17 percent starting material did not appear to be feasible for any of the four alternatives. An analysis of the 48 observations shows that there was an average loss of $5.02 a ton through separation. The alternative with the smallest loss was the separation into 13 and 22 percent products. An average loss of $2.49 a ton resulted with this separation as compared with selling 17 percent dehy without separation.

Ingredients Replaced by Dehydrated Alfalfa

Imputed values of the dehy products determined through parametric linear programming were greatly influenced by the prices of competing feed ingredients. Certain feed ingredients were substituted regularly for dehy products. For example, soybean mill feed, dried corncobs, safflower meal (20 percent), dried malt sprouts, and alfalfa hay were competitively priced in most markets during the three time periods. These ingredients when available in the market competed strongly with dehydrated alfalfa products in the formulation of beef finisher rations.

In Los Angeles the lower protein alfalfa fractions came into the beef finisher ration and frequently replaced all or a portion of corn, milo, or safflower meal. During certain time periods, there were small increases in wheat or milo with low protein dehy. Other minor changes took place between ingredients in the ration so that the nutritional specifications were met.

With the introduction of higher protein dehy into the layer ration in Los Angeles, corn, cottonseed meal, fishmeal, safflower meal, corn gluten meal, or soybean meal was replaced with the higher protein dehy. Small amounts of milo and animal fat were added to the ration.

Lower protein dehy in the Tri-Cities market replaced corn or alfalfa hay in the beef finisher ration during most of the time periods. Milo or malt sprouts came into the ration with dehy to help balance the ration nutritionally. Prices of ingredients and relationships among ingredients changed considerably during the three time periods.

When high protein dehy was substituted in layer rations in Tri-Cities, many of the same high protein ingredients were affected as in Los Angeles. However, grains were also affected--one was substituted for another to obtain

the nutritional balance. Cottonseed meal, corn gluten meal, soybean meal, milo, or corn was replaced in part by dehy. The addition of dehy to the ration was usually accompanied by increases in soybean meal, meat and bone meal, wheat, or corn.

Fewer ingredients were substituted when dehy was introduced into broiler rations in Atlanta. High protein dehy replaced all or part of the corn gluten meal, soybean meal, or meat and bone meal. Additional quantities of corn and fishmeal frequently were added to the ration with dehy to meet nutritional requirements at a lower price. Although most of the ingredients were maintained in the broiler ration with the addition of dehy, the percentages of each ingredient varied between rations.

In the Boston layer light breed ration the same ingredients were replaced by dehy as in other markets. Several other ingredients were substituted at times. Ingredients replaced all or in part by dehy were soybean meal, corn gluten meal, meat and bone meal, corn, or barley. Increased quantities of feather meal, meat and bone meal, corn, wheat, or fishmeal were added to the ration as dehy was added. When dehy came into a ration, it either substituted for a single ingredient on a pound for pound basis or affected several ingredients.

Ingredient prices in all markets varied considerably. Market prices reflect the supply and demand situation for each ingredient. With a short supply and resulting higher prices of certain ingredients, all ingredient prices tend to be affected. In this type of situation, a least cost ration is computed by substituting the lowest cost ingredients that will satisfy ration requirements.

COSTS OF AIR SEPARATION[3/]

Air separation may be performed with systems using different combinations of equipment. In system I the dehydrated alfalfa moves from the dehydrator through a positive air system fan and then on to the separator. From the separator both the fine and coarse fractions are pelleted.

System II has the same basic equipment in the receiving and dehydrating operation as system I. As the dehydrated alfalfa moves from the dehydrator it goes through a grinder. The ground material is then separated and the products are pelleted. Both the fine and coarse particles are smaller than in system I.

In system III the receiving, dehydrating, and separation operations remain the same as in system I. The fine material is pelleted as it leaves the separator. However, the coarse fraction is ground. This reduces the amount of grinding done by the pellet mill and will increase the mill's efficiency.

3/ Information in this section is based on data in (28).

Costs of separation using these different systems are shown in table 7. Costs vary widely with both the system and plant size. For example, with system I, costs range from $1.70 a ton in the smallest plant to $0.30 a ton in the largest. System II has costs ranging from $3.24 per ton in the smallest plant to $1.03 in the largest. These estimated costs approximate the extreme limits in separation costs with these particular size plants.

Table 7--Costs of alfalfa dehydration and separation: Fixed, variable, and total costs per ton[1/]

Plant capacity and cost item [2/]	Dehydration cost	Costs of separation		
		System I	System II	System III
			Dollars	
10,000 lb./hr.				
Fixed	6.01	1.58	1.91	1.91
Variable	12.36	.12	1.33	.82
Total	18.37	1.70	3.24	2.73
12,000 lb./hr.				
Fixed	5.49	1.35	1.64	1.63
Variable	11.61	[3/](.03)	1.02	.58
Total	17.10	1.32	2.66	2.21
18,000 lb./hr.				
Fixed	3.96	.85	1.07	1.04
Variable	9.92	.05	.83	.47
Total	13.88	.90	1.90	1.51
22,000 lb./hr.				
Fixed	3.32	.68	.83	.82
Variable	9.29	.06	.77	.45
Total	12.61	.74	1.60	1.27
30,000 lb./hr.				
Fixed	2.86	.53	.66	.66
Variable	8.72	[3/](.05)	.50	.26
Total	11.58	.48	1.16	.92
33,000 lb./hr.				
Fixed	2.75	.45	.58	.56
Variable	8.26	[3/](.15)	.45	.15
Total	11.01	.30	1.03	.71

1/ Developed from (28), table 11.
2/ Capacity based on evaporative capacity per hour.
3/ An actual reduction in cost occurred because of savings in power costs due to use of different equipment.

These are total costs and are very important in deciding whether to install separation equipment. However, after the separation equipment has been installed, cost estimates would be different. After equipment has been installed it becomes a fixed cost whether it is used or remains idle. Under these circumstances, a dehydrator would consider separation any time the variable expenses could be covered. This would result in a considerably different evaluation. For example, in several different sized plants the variable costs for system I are slightly less than the variable costs in dehydration plants without separation. Total costs are greater with separation but variable costs may be less per unit of output. Reduced electrical cost, because of use of different equipment, is largely responsible for this difference.

Quick Evaluation by Nomograph

An alfalfa dehydrator should be able to quickly evaluate the profitability of separation versus nonseparation. In this evaluation process, he must make certain assumptions regarding available supplies and relate them to market demands throughout the year. Through separation, it may be possible to improve both the quality and the value of dehy in the market during the year. It is possible through advanced planning to develop stocks of a particular quality that will be demanded later in the marketing year.

To make an adequate evaluation, a dehydrator must have reasonably good estimates of prices for all dehydrated alfalfa products. Market prices are usually available for certain standard dehydrated alfalfa products. In deciding if separation would be profitable, the dehydrator must have an estimate of the prices that can be obtained for all products. This can be obtained by using a device called a nomograph.

Figure 1 illustrates this technique using 15 percent dehydrated alfalfa as a starting material. The vertical scales are in units of dollars per ton. The scale on the left shows the price of the higher protein fraction obtained from separation. The scale on the right shows the price of the lower protein separated fraction. The horizontal scale on the lower part of the figure indicates the percentage yield of the lower protein fraction.

A third vertical scale can be drawn at a point on the horizontal scale that represents a particular separation alternative. In figure 1, three separation alternatives shown in table 4 are represented: Separation of 15 percent protein starting material into 13 percent protein material and either 17, 20, or 22 percent protein material. The percentage of protein in each fraction depends on the degree of separation. Separation into 13 and 20 percent protein products (alternative II), for example, would yield by weight 71 percent of the 13 percent protein product and 29 percent of the 20 percent protein product. Separation percentages for other starting materials and the yields of separation products are given in table 4.

To evaluate the feasibility of separation using the nomograph, at least two prices must be known. These can be the price of the starting material or of the separated products. If only one price is known it may be possible to estimate the second price. Locate these two prices on their appropriate vertical scales of the nomograph and draw a straight line through them

Nomograph for Determining Values of Dehydrated Alfalfa Products Obtained from Separating 15% Protein Raw Material

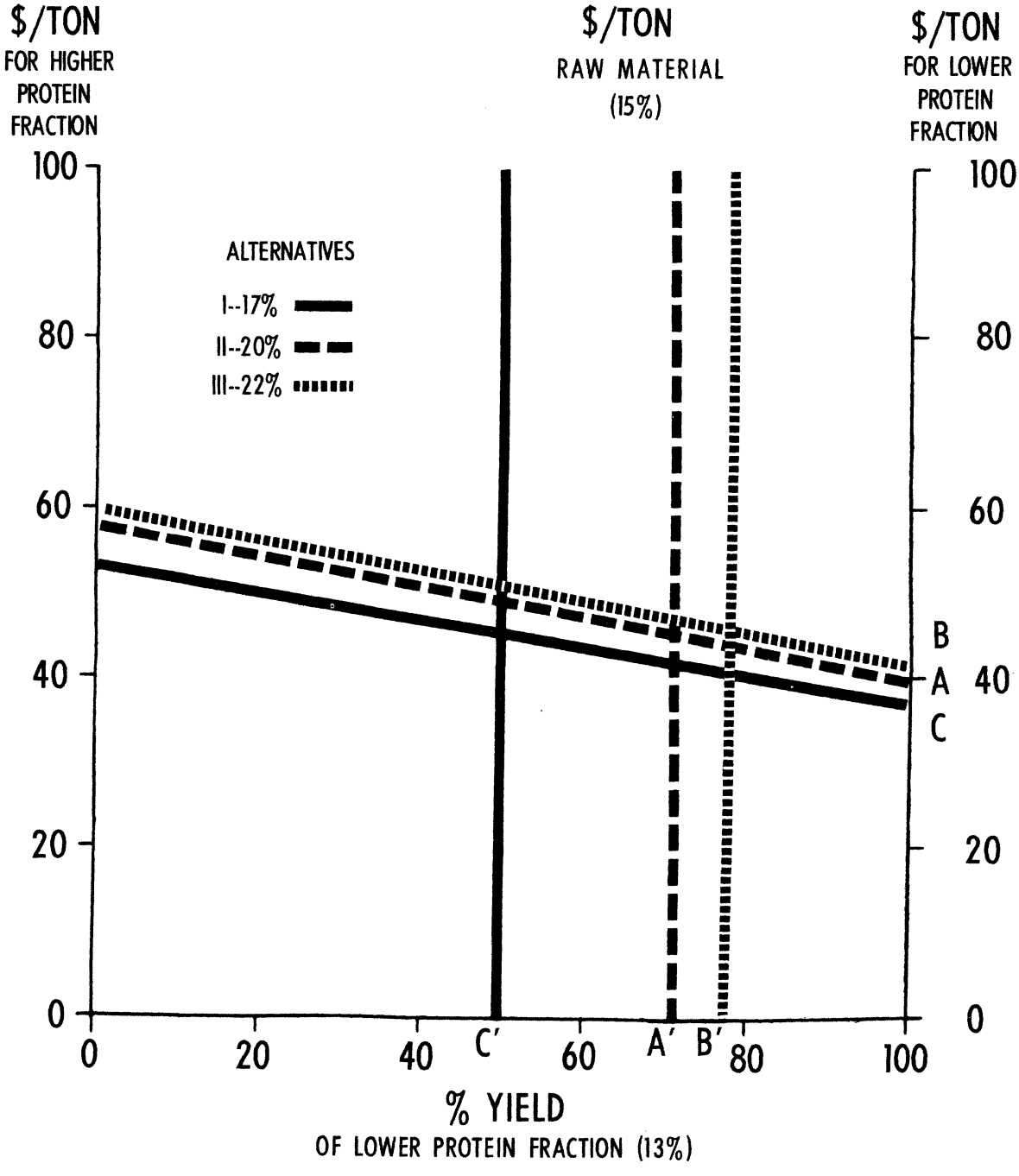

Figure 1

intersecting the third vertical scale. This point of intersection will indicate the price of the third product.

In figure 1, alternative II, the Los Angeles market price for 20 percent dehy and the imputed value of 15 percent protein dehy were used in plotting the line A. The price for 20 percent protein dehy on the left scale was $58.00 per ton and the value for 15 percent on the center scale (A^1) was $45.40 (table 5). Line A through these points crosses the scale on the right at about $39. This means that to break even the dehydrator would have to receive at least $39 per ton for the 13 percent separated material. The imputed value for 13 percent is $40.80 (table 5), so in this case separation probably would be feasible. In actual practice, of course, the dehydrator who wished to use a nomograph would probably not have imputed values for his separation products.

The other alternatives appear to be even more profitable. With line C, alternative I, (separation into 17 and 13 percent dehy), there is $4 a ton difference between the break-even price and the imputed value of 13 percent. With line B, alternative III (separation into 22 and 13 percent dehy), there is a spread of about $11 per ton between the break-even price and the imputed value of 22 percent. These differences must be applied to the quantities of each product obtained from the separation for an estimate of total additional value.

After the market prices or values from sale of the products have been estimated, it is necessary to account for the additional cost of separation. The question of which separated material should bear the burden of cost is immaterial so long as sale of both products will yield an increase in value over the unseparated product.

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APPENDIX A

Table A-1--Nutritional values of ingredients used in poultry rations[1/]

Nutrient name	Unit	Alfalfa dehydrated (20% protein)	Barley	Calcium carbonate	Corn	Corn gluten meal (60% protein)	Cottonseed meal (41% protein)	Deflorinated phosphate	Dicalcium phosphate	Fat, animal
Metabolizable energy	Kcal/lb.	780.00	1,210.00	0.00	1,580.00	1,580.00	850.00	0.00	0.00	3,580.00
Protein	Pct.	20.00	10.00	0.00	8.50	60.00	41.00	0.00	0.00	0.00
Arginine	do.	0.98	0.43	0.00	0.41	1.82	3.70	0.00	0.00	0.00
Glycine	do.	1.01	0.31	0.00	0.30	1.64	2.04	0.00	0.00	0.00
Isoleucine	do.	0.98	0.35	0.00	0.36	2.81	1.42	0.00	0.00	0.00
Lysine	do.	0.87	0.29	0.00	0.23	0.95	1.50	0.00	0.00	0.00
Methionine	do.	0.33	0.15	0.00	0.17	1.59	0.62	0.00	0.00	0.00
Methionine + cystine	do.	0.56	0.31	0.00	0.32	2.68	1.45	0.00	0.00	0.00
Threonine	do.	0.88	0.30	0.00	0.35	2.17	1.20	0.00	0.00	0.00
Tryptophan	do.	0.46	0.12	0.00	0.08	0.30	0.50	0.00	0.00	0.00
Available phosphorus	do.	0.27	0.16	0.00	0.08	0.19	0.37	16.50	18.50	0.00
Calcium	do.	1.47	0.06	38.00	0.02	0.15	0.15	32.00	22.50	0.00
Fat	do.	3.58	1.80	0.00	3.80	2.10	1.00	0.00	0.00	100.00
Fiber	do.	20.20	6.50	0.00	2.50	1.30	13.00	0.00	0.00	0.00
Xanthophyll	Mg./lb.	149.00	0.00	0.00	9.00	106.00	0.00	0.00	0.00	0.00
Choline	do.	730.00	430.00	0.00	240.00	150.00	1,300.00	0.00	0.00	0.00
Vitamin K	do.	6.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Alphatocopherol	do.	67.00	2.80	0.00	10.00	0.00	6.80	0.00	0.00	0.00
Vitamin A	MIU./lb.	164.00	0.00	0.00	3.10	7.50	0.00	0.00	0.00	0.00
Riboflavin	Mg./lb.	7.00	0.59	0.00	0.50	0.70	2.30	0.00	0.00	0.00
Folic acid	do.	1.20	0.23	0.00	0.09	0.10	1.00	0.00	0.00	0.00
Niacin	do.	25.00	20.00	0.00	10.00	25.00	18.00	0.00	0.00	0.00
Pantothenic acid	do.	15.00	3.30	0.00	2.30	3.80	6.40	0.00	0.00	0.00

Continued

Table A-1--Nutritional values of ingredients used in poultry rations--Continued

Nutrient name	Unit	Fat, hydrolyzed vegetable + animal	Feather-meal (85% protein)	Fishmeal, herring (70% protein)	Fishmeal, menhaden (60% protein)	Fishmeal, Peruvian (65% protein)	Lysine (50%)	Methionine hydroxy analog	Meat meal (55% protein)	Meat & bone meal (50% protein)
Metabolizable energy	Kcal/lb.	3,700.00	1,078.00	1,332.00	1,246.00	1,160.00	0.00	0.00	900.00	900.00
Protein	Pct.	0.00	85.00	70.00	60.00	65.00	59.90	0.00	55.00	50.00
Arginine	do.	0.00	3.94	5.30	3.60	3.38	0.00	0.00	3.50	3.15
Glycine	do.	0.00	4.76	4.60	3.88	4.29	0.00	0.00	7.30	6.60
Isoleucine	do.	0.00	2.66	3.00	3.10	2.96	0.00	0.00	1.73	1.49
Lysine	do.	0.00	1.05	5.70	4.34	4.05	50.00	0.00	2.65	2.44
Methionine	do.	0 00	0.37	2.45	1.99	1.93	0.00	80.00	0.66	0.53
Methionine + cystine	do.	0.00	2.35	3.18	3.22	2.81	0.00	80.00	1.33	1.10
Threonine	do.	0.00	2.80	2.88	2.34	2.45	0.00	0.00	1.68	1.44
Tryptophan	do.	0.00	0.40	0.75	0.54	0.66	0.00	0.00	0.36	0.33
Available phosphorus	do.	0.00	0.75	2.00	3.00	2.80	0.00	0.00	4.00	5.00
Calcium	do.	0.00	0.20	3.00	5.00	4.20	0.00	0.00	8.00	10.00
Fat	do.	100.00	2.50	7.00	10.00	4.10	0.00	0.00	6.00	9.50
Fiber	do.	0.00	1.50	1.00	1.00	1.00	0.00	0.00	2.50	2.50
Xanthophyll	Mg./lb.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Choline	do.	0.00	400.00	1,820.00	1,400.00	1,680.00	0.00	0.00	890.00	990.00
Vitamin K	do.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Alphatocopherol	do.	0.00	0.00	12.00	4.10	1.50	0.00	0.00	0.45	0.45
Vitamin A	MIU./lb.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Riboflavin	Mg./lb.	0.00	0.91	4.10	2.20	3.00	0.00	0.00	2.40	2.00
Folic acid	do.	0.00	0.10	1.10	0.09	0.09	0.00	0.00	0.02	0.02
Niacin	do.	0.00	9.40	40.00	25.00	29.00	0.00	0.00	26.00	22.00
Pantothenic acid	do.	0.00	4.00	5.20	4.00	4.00	0.00	0.00	2.20	1.70

Continued

Table A-1--Nutritional values of ingredients used in poultry rations--Continued

Nutrient name	Unit	Milo (sorghum)	Poultry byproduct meal (55% protein)	Rice bran	Safflower meal (42% protein)	Soybean meal (44% protein)	Soybean meal (49% protein)	Wheat HRW	Wheat middlings	Wheat millrun, west coast
Metabolizable energy	Kcal/lb.	1,505.00	1,260.00	670.00	770.00	1,020.00	1,050.00	1,410.00	794.00	733.00
Protein	Pct.	8.50	55.00	13.50	42.00	44.00	49.00	11.73	11.90	12.60
Arginine	do.	0.33	3.20	1.12	3.65	3.00	3.34	0.59	0.84	0.85
Glycine	do.	0.30	2.93	0.74	2.29	1.80	1.99	0.53	0.68	0.69
Isoleucine	do.	0.40	2.33	0.53	1.68	2.17	2.42	0.45	0.36	0.38
Lysine	do.	0.21	2.57	0.65	1.20	2.58	2.88	0.33	0.50	0.51
Methionine	do.	0.17	1.16	0.32	0.68	0.63	0.70	0.20	0.18	0.19
Methionine + cystine	do.	0.32	2.11	0.63	1.39	1.29	1.44	0.53	0.47	0.47
Threonine	do.	0.30	2.03	0.51	1.30	1.72	1.91	0.36	0.41	0.41
Tryptophan	do.	0.10	0.46	0.22	0.97	0.63	0.70	0.15	0.17	0.17
Available phosphorus	do.	0.10	1.70	0.46	1.19	0.20	0.21	0.11	0.33	0.30
Calcium	do.	0.03	3.60	0.12	0.34	0.25	0.20	0.04	0.08	0.08
Fat	do.	2.80	12.00	0.80	1.00	0.50	0.90	1.50	4.00	3.80
Fiber	do.	2.50	2.50	15.20	14.50	7.00	2.90	2.24	8.80	8.00
Xanthophyll	Mg./lb.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Choline	do.	310.00	2,700.00	570.00	1,600.00	1,240.00	1,250.00	440.00	685.00	697.00
Vitamin K	do.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Alphatocopherol	do.	5.40	0.00	27.00	0.00	1.40	1.50	5.10	11.80	12.00
Vitamin A	MIU./lb.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Riboflavin	Mg./lb.	0.54	4.00	1.20	1.30	1.55	1.40	0.69	1.58	1.52
Folic acid	do.	0.11	0.23	1.00	0.87	0.32	1.60	0.15	0.42	0.39
Niacin	do.	19.00	40.00	140.00	11.00	12.00	9.80	23.60	77.10	69.00
Pantothenic acid	do.	5.20	4.00	11.00	22.00	6.60	6.60	3.90	9.90	9.50

1/ Developed by Western Regional Research Center, ARS, Albany, Calif.

Table A-2--Nutritional values of ingredients used in ruminant rations[1/]

Ingredient[2/]	TDN	Total protein	Digestible protein	Nonprotein nitrogen	Total fat	Calcium	Phosphorus	Vitamin E	Fiber	Dry matter	Roughage, dry wt.
				Percent				Mg. per lb.		Percent	
Alfalfa hay (15%)	50.00	15.60	10.80	0.00	1.90	1.48	0.23	23.90	28.20	90.00	100.00
Animal fat	203.00	0.00	0.00	0.00	99.40	0.00	0.00	3.60	0.00	100.00	0.00
Barley, Midwest	74.00	11.60	8.70	0.00	1.90	0.08	0.42	16.50	5.00	89.00	0.00
Barley, Pacific	73.00	9.70	7.30	0.00	2.20	0.06	0.40	16.50	6.20	89.00	0.00
Beet pulp	66.00	9.10	4.10	0.00	0.60	0.68	0.10	0.00	19.00	91.00	0.00
Brewers grains, dried	61.00	25.90	19.10	0.00	6.20	0.27	0.50	12.20	15.00	92.00	0.00
Calcium carbonate	0.00	0.00	0.00	0.00	0.00	38.00	0.00	0.00	0.00	100.00	0.00
Citrus pulp	69.00	6.60	3.50	0.00	4.60	1.96	0.12	0.00	13.00	90.00	0.00
Corn, ground	78.00	8.80	6.50	0.00	3.80	0.03	0.27	9.00	2.00	86.00	0.00
Corncobs, dried	42.00	2.50	0.00	0.00	0.50	0.11	0.04	0.00	32.40	90.00	100.00
Corn gluten feed	74.00	25.30	21.80	0.00	2.40	0.46	0.77	6.70	8.00	90.00	0.00
Cottonseed hulls	37.00	3.90	0.00	0.00	1.40	0.14	0.09	0.00	42.90	90.00	100.00
Cottonseed meal (41%)	69.00	41.00	33.20	0.00	2.00	0.16	1.20	4.20	12.00	94.00	0.00
Deflor. phos. 33-18	0.00	0.00	0.00	0.00	0.00	33.00	18.00	0.00	0.00	100.00	0.00
Dist. grains, dried	77.00	29.10	23.10	0.00	8.90	0.20	0.55	13.80	11.50	92.00	0.00
Linseed meal	69.00	35.10	30.90	0.00	1.70	0.40	0.83	3.50	9.00	91.00	0.00
Malt sprouts, dried	64.00	26.20	20.40	0.00	1.40	0.22	0.73	1.90	14.00	93.00	0.00
Milo, steam rolled	71.00	11.00	6.30	0.00	2.80	0.04	0.29	5.50	2.00	89.00	0.00
Molasses, cane	68.00	3.20	1.80	0.00	0.10	0.89	0.08	2.50	0.00	75.00	0.00
Oats	70.00	9.00	6.70	0.00	5.40	0.09	0.33	9.30	11.00	91.00	0.00
Peanut meal	76.00	45.80	41.20	0.00	5.00	0.17	0.57	1.30	11.00	92.00	0.00
Rice bran	49.00	14.00	9.10	0.00	1.00	0.12	1.48	27.60	13.00	91.00	0.00
Safflower meal	50.00	21.40	17.20	0.00	3.90	0.34	0.84	0.40	32.30	92.00	100.00
Soybean meal (44%)	72.00	45.80	39.00	0.00	0.90	0.32	0.67	1.40	6.00	89.00	0.00
Soybean millfeed	56.00	19.20	14.50	0.00	6.10	0.38	0.19	0.00	28.00	93.00	100.00
Urea	0.00	281.00	266.00	44.80	0.00	0.00	0.00	0.00	0.00	100.00	0.00
Wheat	78.00	11.60	9.20	0.00	1.60	0.03	0.36	6.20	2.20	86.00	0.00
Wheat bran	62.00	15.10	12.50	0.00	3.40	0.09	1.30	11.00	10.30	86.00	0.00
Wheat middlings	75.00	15.60	12.20	0.00	4.00	0.08	1.09	16.00	8.80	86.00	0.00
Wheat millrun, WC	73.00	16.10	10.90	0.00	3.80	0.08	0.99	16.10	8.00	86.00	0.00

1/ Developed by Western Regional Research Center, ARS, Albany, Calif.
2/ Percentages in parentheses refer to protein content.

Table A-3--Nutritional specifications for poultry rations[1/]

Nutrient or ingredient name[2/]	Unit	Quantity of each requirement by type of ration[3/]	
		Broiler finisher	Layer light breed
Metabolizable energy	Kcal/lb.	1450.0000	1350.0000
Arginine, min.	Percent	1.1600	0.8000
Glycine, min.	do.	0.8700	0.6000
Isoleucine, min.	do.	0.7800	0.5000
Lysine, min.	do.	1.1100	0.5000
Methionine, min.	do.	0.4000	0.2800
Meth. + cystine, min.	do.	0.7700	0.5300
Threonine, min.	do.	0.7200	0.4000
Tryptophan, min.	do.	0.2100	0.1500
Avail. phosphorus, min.	do.	0.4500	0.3000
Calcium, min.	do.	0.8000	3.2500
Added fat, max.	do.	10.0000	10.0000
Fiber, max.[4/]	do.	100.0000	100.0000
Xanthophyll, min.	Mg./lb.	13.0000	7.0000
Fishmeal, max.	Percent	10.0000	5.0000
Ethoxyquin, exact	do.	0.0125	0.0125
Salt, exact	do.	0.2500	0.2500
Mineral-vitamin mix, exact[5/]	do.	0.5000	0.5000
Cottonseed meal (41%), max.	do.	7.5000	7.5000
Meat meal (55%), max.	do.	5.0000	5.0000
Meat-bone meal (50%), max.	do.	5.0000	5.0000
Feathermeal (85%), max.	do.	2.5000	2.5000
Poultry byproduct meal (55%), max.	do.	5.0000	5.0000
Alfalfa, dehy (20%), max.	do.	5.0000	10.0000
Rice bran, max.	do.	5.0000	5.0000

1/ Developed by Western Regional Research Center, ARS, Albany, Calif.

2/ Percentages in parentheses refer to protein content.

3/ Rations with lower energy levels can be computed by proportionately reducing requirements for energy, amino acids, calcium, xanthophyll, salt, and mineral-vitamin mix.

4/ Although the fiber specification is not limited, the quantity of fiber in the ration is restricted by the metabolizable energy requirement to a range of less than 5 percent for poultry rations.

5/ The composition of the mineral-vitamin mix varies for each ration. The prices used for these mixes in the economic analysis were quotations for typically available commercial mixes.

Table A-4--Nutritional specifications for beef finisher with roughage ration1/

Item	Percent of each requirement
	Percent
TDN, min.	75.00
Total protein, min.	11.00
Digestible protein, min.	8.25
NPN, max.2/	.64
Calcium, min.	.25
Calcium, max.	.75
Phosphorus, min.	.20
Phosphorus, max.	1.20
Salt, exact	.25
Trace nutrient mix, exact	.50
Total fat, max.3/	100.00
Molasses, min.	2.50
Molasses, max.	10.00
Dry matter, min.	0.00
Dehydrated forage, min.	2.50
Fiber, max.3/	100.00
Roughage, dry, min.	10.00
Roughage, dry, max.	20.00
Alfalfa, dehy (17% protein), max.3/	100.00
Alfalfa, dehy (15% protein), max.3/	100.00
Animal fat, max.	5.00
Beet pulp, max.	20.00
Brewers grains, dried, max.	20.00
Citrus pulp, max.	20.00
Corncobs, max.	5.00
Corn gluten feed, max.	20.00
Cottonseed hulls, max.	5.00
Distillers grains, dried, max.	20.00
Malt sprouts, dried, max.	20.00
Rice bran, max.	20.00
Safflower meal (20% protein), max.	20.00
Soybean millfeed, max.	20.00
Wheat bran, max.	20.00
Wheat middlings, max.	20.00
Wheat millrun, west coast, max.	20.00

1/ Developed by Western Regional Research Center, ARS, Albany, Calif.

2/ NPN = nonprotein nitrogen; for example, urea.

3/ For nutrients where the maximum specification is not limited (100%) the quantity in the ration is effectively restricted by other nutritional requirements and is always considerably less than 100 percent.

Table A-5--Feed ingredient prices for Atlanta in selected time periods

Feed ingredient[1/]	11/66-1/67	8/68-10/68	11/71-1/72
	Dollars per ton		
Alfalfa, dehy (17%)	69.80	45.20	61.80
Alfalfa, dehy (20%)	75.80	51.20	67.80
Calcium carbonate	6.60	6.60	10.40
Corn	53.00	41.00	46.60
Corn gluten meal (60%)	141.80	139.40	154.80
Cottonseed meal (41%)	87.40	73.40	77.40
Deflor. phosphate	69.40	72.80	81.80
Dical. phosphate	93.40	73.80	84.80
Fat, animal	131.40	97.60	123.20
Feathermeal (85%)	95.40	102.40	88.00
Fishmeal, menhaden (62%)	155.60	145.40	172.60
Fishmeal, Peruvian (65%)	155.20	139.20	168.00
Lysine (50%)	1250.00	1250.00	829.00
Meat and bone meal (50%)	107.80	96.20	97.40
Methionine hydroxy analog	1701.40	1260.00	1480.00
Milo (sorghum)	51.40	45.80	41.60
Oats	56.00	45.60	66.40
Poultry byproduct meal (55%)	114.00	105.60	111.20
Rice bran	61.20	44.80	52.20
Salt	20.20	20.20	18.80
Soybean meal (44%)	89.40	90.40	87.20
Soybean meal (49%)	99.40	100.20	95.60
Wheat	60.80	43.00	52.60
Wheat bran	61.20	40.20	60.20
Wheat middlings	61.60	41.20	58.00

1/ Percentages in parentheses refer to protein content.

Table A-6--Feed ingredient prices for Boston in selected time periods

Feed ingredient[1/]	11/66-1/67	8/68-10/68	11/71-1/72
		Dollars per ton	
Alfalfa, dehy (17%)	71.00	49.20	61.60
Alfalfa, dehy (20%)	79.40	54.20	66.60
Barley	65.20	54.60	61.60
Calcium carbonate	3.60	3.60	7.20
Corn	60.40	45.40	57.20
Corn gluten meal (60%)	144.00	142.80	130.00
Cottonseed meal (41%)	103.00	93.40	87.00
Deflor. phosphate	77.20	81.80	86.00
Dical. phosphate	100.00	84.60	106.00
Fat, animal	140.40	105.60	125.00
Fat, hyd. veg. + animal	147.80	104.80	123.00
Feathermeal (85%)	110.00	120.00	114.00
Fishmeal, herring (70%)	181.00	176.80	210.00
Fishmeal, menhaden (62%)	152.00	138.40	176.00
Fishmeal, Peruvian (65%)	147.60	129.20	170.00
Lysine (50%)	1250.00	1250.00	829.00
Meat and bone meal (50%)	104.80	94.80	101.50
Methionine hydroxy analog	1701.40	1260.00	1480.00
Milo (sorghum)	59.20	53.00	56.60
Poultry byproduct meal (55%)	125.00	110.00	80.00
Salt	43.00	43.60	45.00
Soybean meal (44%)	98.40	82.80	86.00
Soybean meal (49%)	86.00	92.00	97.00
Wheat	68.20	50.20	59.20
Wheat middlings	65.00	47.80	66.50

1/ Percentages in parentheses refer to protein content.

Table A-7--Feed ingredient prices for Los Angeles in selected time periods

Feed ingredient[1/]	11/66-1/67	8/68-10/68	11/71-1/72
	Dollars per ton		
Alfalfa hay (15%)	39.60	30.00	46.20
Alfalfa, dehy (17%)	53.40	55.20	56.00
Alfalfa, dehy (20%)	58.00	57.00	58.60
Barley	58.80	50.00	65.60
Beet pulp	56.40	44.80	55.00
Brewers grains, dried	56.20	60.00	63.00
Calcium carbonate	11.00	10.40	11.20
Citrus pulp	50.00	40.80	50.40
Corn	59.60	53.60	59.00
Corn gluten feed	71.40	63.00	68.40
Corn gluten meal (60%)	157.80	150.80	154.40
Cottonseed meal (41%)	76.40	76.00	81.80
Deflor. phosphate	92.20	89.00	93.00
Dical. phosphate	99.00	106.20	110.00
Distillers grains, dried	83.00	87.20	80.00
Fat, animal	131.80	100.00	137.40
Fat, hyd. veg. + animal	146.60	123.00	170.00
Feathermeal (85%)	110.00	97.80	115.40
Fishmeal, Peruvian (65%)	144.00	132.00	157.60
Linseed meal	91.00	93.60	91.00
Lysine (50%)	1250.00	1250.00	829.00
Meat and bone meal (50%)	101.20	98.60	104.20
Methionine hydroxy analog	1701.40	1260.00	1480.00
Milo (sorghum)	50.60	46.80	55.00
Molasses, cane	30.80	25.00	27.20
Oats	61.80	59.80	64.60
Poultry byproduct meal (55%)	121.80	103.00	131.40
Rice bran	44.80	38.60	48.60
Salt	20.00	20.00	30.00
Safflower meal (42%)	81.60	77.00	84.80
Safflower meal (20%)	42.00	36.80	43.80
Soybean meal (44%)	99.40	101.00	104.80
Soybean meal (49%)	108.80	113.00	111.80
Urea	92.00	79.00	68.00
Wheat	61.20	52.20	61.60
Wheat bran	62.00	45.40	62.00
Wheat millrun, west coast	56.20	40.80	58.60

1/ Percentages in parentheses refer to protein content.

Table A-8--Feed ingredient prices for Tri-Cities in selected time periods

Feed ingredient[1/]	11/66-1/67	8/68-10/68	11/71-1/72
	Dollars per ton		
Alfalfa hay (15%)	35.00	33.40	35.00
Alfalfa, dehy (17%)	68.20	41.60	52.40
Alfalfa, dehy (20%)	74.80	49.20	59.40
Barley	53.80	43.80	50.80
Beet pulp	73.60	76.20	63.60
Brewers grains, dried	65.60	48.40	50.00
Calcium carbonate	11.00	12.00	11.60
Corn	51.60	39.00	44.60
Corncobs, dried	20.00	22.60	25.60
Corn gluten feed	58.00	41.00	52.00
Corn gluten meal (60%)	134.40	130.40	118.00
Cottonseed meal (41%)	90.40	83.40	82.80
Cottonseed hulls	31.40	25.20	29.40
Deflor. phosphate	74.00	73.20	80.00
Dical. phosphate	87.60	80.60	99.00
Distillers grains, dried	68.20	55.40	62.00
Fat, animal	139.20	103.40	140.00
Feathermeal (85%)	116.20	110.00	95.00
Fishmeal, menhaden (62%)	163.40	156.00	191.00
Fishmeal, Peruvian (65%)	159.40	144.20	196.00
Linseed meal	83.00	79.40	82.00
Lysine (50%)	1250.00	1250.00	829.00
Malt sprouts, dried	54.20	35.40	44.20
Meat and bone meal (50%)	99.60	95.00	98.60
Methionine hydroxy analog	1701.40	1260.00	1480.00
Milo (sorghum)	47.20	40.80	44.60
Molasses, cane	40.20	34.00	33.20
Oats	50.60	39.40	44.80
Poultry byproduct meal (55%)	138.00	132.00	120.00
Rice bran	62.00	49.20	54.40
Salt	20.20	22.00	18.00
Soybean meal (44%)	86.20	38.20	83.40
Soybean meal (49%)	94.00	98.00	89.40
Soybean millfeed	62.40	47.80	52.60
Urea	80.00	60.00	52.00
Wheat	58.60	40.40	49.00
Wheat bran	56.80	38.20	49.80
Wheat middlings	58.20	39.80	50.20

1/ Percentages in parentheses refer to protein content.

APPENDIX B

Comparison of Imputed Values and Market Prices

The following tables provide detailed information that was used to develop the differences shown in table 6. Imputed values and market prices used in this table are from table 5. Tables B-1 through B-10 illustrate the potential for separating high, medium, and low protein starting materials for the three time periods and four markets.

Tables B-1 through B-3 show the three alternative separations of a 15 percent protein starting material. Four alternative separations of 17 percent starting material are in tables B-4 through B-7. The remaining tables deal with the separation of 20 percent starting material by the three alternatives. As mentioned previously, numerous alternatives are possible with starting materials of varying proteins. These levels and alternatives were used since they represent the extremes that a dehydrator is likely to experience.

Table B-1--Separation of 15 percent alfalfa: Imputed values and market prices by time periods for selected markets1/

Time periods and markets	Imputed value 13%	Market price 17%	Weighted average 2/	Imputed value 15% 3/	Difference due to separation
			Dollars per ton		
Nov. 1966 - Jan. 1967					
Los Angeles	40.80	53.40	47.10	45.40	+ 1.70
Tri-Cities	34.80	68.20	51.50	37.60	+13.90
Atlanta-Tri-Cities	34.80	69.80	47.40	37.60	+ 9.80
Boston-Tri-Cities	34.80	71.00	52.90	37.60	+15.30
Aug. 1968 - Oct. 1968					
Los Angeles	35.40	55.20	45.30	37.80	+ 7.50
Tri-Cities	33.40	41.60	37.50	35.40	+ 2.10
Atlanta-Tri-Cities	33.40	45.20	39.30	35.40	+ 3.90
Boston-Tri-Cities	33.40	49.20	41.30	35.40	+ 5.90
Nov. 1971 - Jan. 1972					
Los Angeles	42.60	56.00	49.30	45.00	+ 4.30
Tri-Cities	35.20	52.40	43.80	38.00	+ 5.80
Atlanta-Tri-Cities	35.20	61.80	48.50	38.00	+10.50
Boston-Tri-Cities	35.20	61.60	48.40	38.00	+10.40

1/ Separation of a 15 percent protein raw material will yield about 50 percent of the 13 percent product and 50 percent of the 17 percent product.

2/ Imputed value for 13 percent and market price for 17 percent products have been weighted to determine average value of the total product.

3/ Imputed values used are for Los Angeles and Tri-Cities.

Table B-2--Separation of 15 percent alfalfa: Imputed values and market prices by time periods for selected markets1/

Time periods and markets	Imputed value 13%	Market price 20%	Weighted average 2/	Imputed value 15% 3/	Difference due to separation
			Dollars per ton		
Nov. 1966 - Jan. 1967					
Los Angeles	40.80	58.00	45.82	45.40	+ 0.42
Tri-Cities	34.80	74.80	46.40	37.60	+ 8.80
Atlanta-Tri-Cities	34.80	75.80	46.70	37.60	+ 9.10
Boston-Tri-Cities	34.80	79.40	47.70	37.60	+10.10
Aug. 1968 - Oct. 1968					
Los Angeles	35.40	57.00	41.70	37.80	+ 3.90
Tri-Cities	33.40	49.20	38.00	35.40	+ 2.60
Atlanta-Tri-Cities	33.40	51.20	38.55	35.40	+ 3.15
Boston-Tri-Cities	33.40	54.20	39.40	35.40	+ 4.00
Nov. 1971 - Jan. 1972					
Los Angeles	42.60	58.60	47.25	45.00	+ 2.25
Tri-Cities	35.20	59.40	42.25	38.00	+ 4.25
Atlanta-Tri-Cities	35.20	67.80	44.70	38.00	+ 6.70
Boston-Tri-Cities	35.20	66.60	44.30	38.00	+ 6.30

1/ Separation of a 15 percent protein raw material will yield about 71 percent of the 13 percent product and 29 percent of the 20 percent product.

2/ Imputed value of 13 percent and market price for 20 percent products have been weighted to determine average value of the total product.

3/ Imputed values used for Los Angeles and Tri-Cities.

Table B-3--Separation of 15 percent alfalfa: Imputed values and market prices by time periods for selected markets[1/]

Time periods and markets	Imputed value			Imputed value 15% [3/]	Difference due to separation
	13%	22%	Weighted average[2/]		
	Dollars per ton				
Nov. 1966 - Jan. 1967					
Los Angeles	40.80	71.40	47.70	45.40	+ 2.30
Tri-Cities	34.80	78.40	44.60	37.60	+ 7.00
Atlanta-Tri-Cities	34.80	96.40	48.70	37.60	+11.10
Boston-Tri-Cities	34.80	91.60	44.20	37.60	+ 6.60
Aug. 1968 - Oct. 1968					
Los Angeles	35.40	67.60	42.70	37.80	+ 4.90
Tri-Cities	33.40	63.40	44.20	35.40	+ 8.80
Atlanta-Tri-Cities	33.40	64.20	40.40	35.40	+ 5.00
Boston-Tri-Cities	33.40	62.20	39.90	35.40	+ 4.50
Nov. 1971 - Jan. 1972					
Los Angeles	42.60	68.80	48.50	45.00	+ 3.50
Tri-Cities	35.20	64.20	41.75	38.00	+ 3.75
Atlanta-Tri-Cities	35.20	88.20	47.15	38.00	+ 9.15
Boston-Tri-Cities	35.20	75.20	44.20	38.00	+ 6.20

1/ Separation of a 15 percent protein raw material will yield about 77.5 percent of a 13 percent product and 22.5 percent of a 22 percent product.

2/ Imputed values for 13 and 22 percent products have been weighted to determine average value of the total product.

3/ Imputed values used are for Los Angeles and Tri-Cities.

Table B-4--Separation of 17 percent alfalfa: Imputed values and market prices by time periods for selected markets[1/]

Time periods and markets	Imputed value 13%	Market price 20%	Weighted average 2/	Market price 17% 3/	Difference due to separation
			Dollars per ton		
Nov. 1966 - Jan. 1967					
Los Angeles	40.80	58.00	50.70	53.40	- 2.70
Tri-Cities	34.80	74.80	57.80	68.20	-10.40
Atlanta-Tri-Cities	34.80	75.80	53.40	69.20	-15.80
Boston-Tri-Cities	34.80	79.40	60.44	69.80	- 9.36
Aug. 1968 - Oct. 1968					
Los Angeles	35.40	57.00	47.90	55.20	- 7.30
Tri-Cities	33.40	49.20	42.50	41.60	+ 0.90
Atlanta-Tri-Cities	33.40	51.20	43.65	43.60	+ 0.05
Boston-Tri-Cities	33.40	54.20	45.37	46.00	- 0.63
Nov. 1971 - Jan. 1972					
Los Angeles	42.60	58.60	51.80	56.00	- 4.20
Tri-Cities	35.20	59.40	49.15	52.40	- 3.25
Atlanta-Tri-Cities	35.20	67.80	54.00	57.80	- 3.80
Boston-Tri-Cities	35.20	66.60	53.30	57.70	- 4.40

1/ Separation of a 17 percent protein raw material will yield about 57.5 percent of the 20 percent product and 42.5 percent of the 13 percent product.

2/ Market price for 20 percent and imputed value for 13 percent products have been weighted to determine average value of the total product.

3/ Market prices for each city weighted by the percentage of separated product in each market.

Table B-5--Separation of 17 percent alfalfa: Imputed values and market prices by time periods for selected markets[1/]

Time periods and markets	Imputed value			Market price 17% [3/]	Difference due to separation
	13%	22%	Weighted average[2/]		
	Dollars per ton				
Nov. 1966 - Jan. 1967					
Los Angeles	40.80	71.40	54.60	53.40	+ 1.20
Tri-Cities	34.80	78.40	54.40	68.20	-13.80
Atlanta-Tri-Cities	34.80	96.40	62.60	68.90	- 6.30
Boston-Tri-Cities	34.80	91.60	60.40	69.50	- 9.10
Aug. 1968 - Oct. 1968					
Los Angeles	35.40	67.60	49.90	55.20	- 5.30
Tri-Cities	33.40	63.40	46.90	41.60	+ 5.30
Atlanta-Tri-Cities	33.40	64.20	47.20	43.30	+ 3.90
Boston-Tri-Cities	33.40	62.20	46.40	45.00	+ 1.40
Nov. 1971 - Jan. 1972					
Los Angeles	42.60	68.80	54.40	56.00	- 1.60
Tri-Cities	35.20	64.20	48.20	52.40	- 4.20
Atlanta-Tri-Cities	35.20	88.20	59.00	56.60	+ 2.40
Boston-Tri-Cities	35.20	75.20	53.20	56.60	- 3.40

1/ Separation of a 17 percent raw material will yield about 55 percent of the 13 percent product and 45 percent of the 22 percent product.

2/ Imputed values for the 13 and 22 percent products have been weighted to determine average value of the total product.

3/ Market prices for each city weighted by percentage of separated product in each market.

Table B-6--Separation of 17 percent alfalfa: Imputed values and market prices by time periods for selected markets[1/]

Time periods and markets	Imputed value 15%	Market price 20%	Weighted average [2/]	Market price 17% [3/]	Difference due to separation
			Dollars per ton		
Nov. 1966 - Jan. 1967					
Los Angeles	45.40	58.00	50.50	53.40	- 2.90
Tri-Cities	37.60	74.80	52.50	68.20	-15.70
Atlanta-Tri-Cities	37.60	75.80	57.60	68.90	-11.30
Boston-Tri-Cities	37.60	79.40	54.30	69.30	-15.00
Aug. 1968 - Oct. 1968					
Los Angeles	37.80	57.00	45.50	55.20	- 9.70
Tri-Cities	35.40	49.20	41.00	41.60	- 0.60
Atlanta-Tri-Cities	35.40	51.20	43.10	43.10	--
Boston-Tri-Cities	35.40	54.20	43.00	44.70	- 1.70
Nov. 1971 - Jan. 1972					
Los Angeles	45.00	58.60	50.50	56.00	- 5.50
Tri-Cities	38.00	59.40	46.60	52.40	- 5.80
Atlanta-Tri-Cities	38.00	67.80	54.10	56.16	- 2.06
Boston-Tri-Cities	38.00	66.60	49.50	56.10	- 6.60

1/ Separation of a 17 percent protein raw material will yield about 40 percent of the 20 percent product and 60 percent of the 15 percent product.

2/ Market value for 20 percent and imputed value for 15 percent products have been weighted to determine average value of the total product.

3/ Market prices for each city weighted by the percentage of separated product in each market.

Table B-7--Separation of 17 percent alfalfa: Imputed values and market prices by time periods for selected markets[1/]

Time periods and markets	Imputed value			Market price 17% [3/]	Difference due to separation
	15%	22%	Weighted average[2/]		
	Dollars per ton				
Nov. 1966 - Jan. 1967					
Los Angeles	45.40	71.40	52.80	53.40	- 0.60
Tri-Cities	37.60	78.40	49.20	68.20	-19.00
Atlanta-Tri-Cities	37.60	96.40	54.40	68.60	-14.20
Boston-Tri-Cities	37.60	91.60	53.00	69.00	-16.00
Aug. 1968 - Oct. 1968					
Los Angeles	37.80	67.60	46.30	55.20	- 8.90
Tri-Cities	35.40	63.40	43.40	41.60	+ 1.80
Atlanta-Tri-Cities	35.40	64.20	43.40	42.60	+ 0.80
Boston-Tri-Cities	35.40	62.20	42.90	43.80	- 0.90
Nov. 1971 - Jan. 1972					
Los Angeles	45.00	68.80	51.78	56.00	- 4.22
Tri-Cities	38.00	64.20	45.50	52.40	- 6.90
Atlanta-Tri-Cities	38.00	88.20	52.40	55.00	- 2.60
Boston-Tri-Cities	38.00	75.20	48.60	55.00	- 6.40

1/ Separation of a 17 percent protein raw material will yield about 71.5 percent of the 15 percent product and 28.5 percent of the 22 percent product.

2/ Imputed values for 15 and 22 percent products have been weighted to determine average value of the total product.

3/ Market prices for each city weighted by percentage of separated product in each market.

Table B-8--Separation of 20 percent alfalfa: Imputed values and market prices by time periods for selected markets[1/]

Time periods and markets	Imputed value			Market price 20% [3/]	Difference due to separation
	13%	22%	Weighted average[2/]		
	Dollars per ton				
Nov. 1966 - Jan. 1967					
Los Angeles	40.80	71.40	64.67	58.00	+ 6.67
Tri-Cities	34.80	78.40	68.81	74.80	- 5.99
Atlanta-Tri-Cities	34.80	96.40	83.00	75.60	+ 7.40
Boston-Tri-Cities	34.80	91.60	79.00	78.40	+ 0.60
Aug. 1968 - Oct. 1968					
Los Angeles	35.40	67.60	60.52	57.00	+ 3.52
Tri-Cities	33.40	63.40	56.80	49.20	+ 7.60
Atlanta-Tri-Cities	33.40	64.20	57.40	50.80	+ 6.60
Boston-Tri-Cities	33.40	62.20	56.00	53.00	+ 3.00
Nov. 1971 - Jan. 1972					
Los Angeles	42.60	68.80	63.03	58.60	+ 4.43
Tri-Cities	35.20	64.20	57.82	59.40	- 1.58
Atlanta-Tri-Cities	35.20	88.20	76.60	66.60	+10.00
Boston-Tri-Cities	35.20	75.20	66.40	65.00	+ 1.40

1/ Separation of a 20 percent protein raw material will yield about 22 percent of the 13 percent product and 78 percent of the 22 percent product.

2/ Imputed values of 13 and 22 percent products have been weighted to determine average value of the total product.

3/ Market prices for each city weighted by the percentage of separated product in each market.

Table B-9--Separation of 20 percent alfalfa: Imputed values and market prices by time periods for selected markets[1/]

Time periods and markets	Imputed value			Market price 20% [3/]	Difference due to separation
	15%	22%	Weighted average[2/]		
	Dollars per ton				
Nov. 1966 - Jan. 1967					
Los Angeles	45.40	71.40	63.86	58.00	+ 5.86
Tri-Cities	37.60	78.40	66.55	74.80	- 8.25
Atlanta-Tri-Cities	37.60	96.40	79.34	75.40	+ 3.94
Boston-Tri-Cities	37.60	91.60	75.94	78.00	- 2.06
Aug. 1968 - Oct. 1968					
Los Angeles	37.80	67.60	58.96	57.00	+ 1.96
Tri-Cities	35.40	63.40	55.30	49.20	+ 6.10
Atlanta-Tri-Cities	35.40	64.20	55.85	50.60	+ 5.25
Boston-Tri-Cities	35.40	62.20	54.43	52.60	+ 1.83
Nov. 1971 - Jan. 1972					
Los Angeles	45.00	68.80	61.90	58.60	+ 3.30
Tri-Cities	38.00	64.20	56.60	59.40	- 2.80
Atlanta-Tri-Cities	38.00	88.20	73.64	66.40	+ 7.24
Boston-Tri-Cities	38.00	75.20	64.41	65.40	- 0.99

1/ Separation of a 20 percent protein raw material will yield about 29 percent of the 15 percent product and 71 percent of the 22 percent product.

2/ Imputed values for 15 and 22 percent products have been weighted to determine average value for the total product.

3/ Market prices for each city weighted by percentage of separated product in each market.

Table B-10--Separation of 20 percent alfalfa: Imputed values and market prices by time periods for selected markets 1/

Time periods and markets	Market price 17%	Imputed value 22%	Weighted average 2/	Market price 20% 3/	Difference due to separation
			Dollars per ton		
Nov. 1966 - Jan. 1967					
Los Angeles	53.40	71.40	64.20	58.00	+ 6.20
Tri-Cities	68.20	78.40	74.35	74.80	- 0.45
Atlanta-Tri-Cities	68.20	96.40	85.15	77.65	+ 7.50
Boston-Tri-Cities	68.20	91.60	82.25	75.50	+ 6.75
Aug. 1968 - Oct. 1968					
Los Angeles	55.20	67.60	62.64	57.00	+ 5.64
Tri-Cities	41.60	63.40	54.70	49.20	+ 5.50
Atlanta-Tri-Cities	41.60	64.20	55.20	52.25	+ 2.95
Boston-Tri-Cities	41.60	62.20	54.00	50.45	+ 3.55
Nov. 1971 - Jan. 1972					
Los Angeles	56.00	68.80	63.68	58.60	+ 5.08
Tri-Cities	52.40	64.20	59.55	59.40	+ 0.15
Atlanta-Tri-Cities	52.40	88.20	73.90	65.15	+ 8.75
Boston-Tri-Cities	52.40	75.20	66.10	65.80	+ 0.30

1/ Separation of a 20 percent protein raw material will yield about 40 percent of the 17 percent product and 60 percent of the 22 percent product.

2/ Market value for 17 percent and imputed value for 22 percent products have been weighted to determine average value of the total product.

3/ Market prices for each city weighted by the percentage of separated product in each market.